

The Impact of Outside Factors on North Sumatra Arabica Coffee Exports to International Markets

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ABSTRACT

Arabica coffee is one of North Sumatra's leading export commodities. Global economic dynamics and fluctuations in macroeconomic indicators have the potential to influence its export volume. The objective of this study is to analyze the impact of macroeconomic variables on the export volume of North Sumatra's arabica coffee to its four main destination countries. This study uses secondary data from various official sources. The analysis method employs panel data regression using the Common Effect Model, Fixed Effect Model, and Random Effect Model approaches. The results show a coefficient of determination of 0.8501. The variables of international Arabica coffee prices and the exchange rate of the importing country's currency against the rupiah have a positive and significant effect on Arabica coffee export volume, while the gross domestic product (GDP) of the importing country shows a negative and significant effect on Arabica coffee export volume. These results indicate that increases in global prices and the appreciation of the export destination country's currency drive an increase in Arabica coffee export volume, while the economic growth of the importing country does not have a positive impact on the demand for Arabica coffee from North Sumatra, Indonesia. The implication of this study is the importance of monitoring global prices and the appreciation of the export destination country's currency in order to increase Arabica coffee export volume..

Key words: Coffee prices; exchange rates; gross domestic product; panel regression.

1 INTRODUCTION

One of the plantation commodities that significantly contributes to Indonesia's growth in non-oil and gas exports is coffee. Following Brazil, Vietnam, and Colombia as the world's top three producers of coffee, Indonesia ranks fourth. About 61% of the coffee produced is exported, with the remaining 39% being utilised to satisfy domestic demand. The primary goal of marketing Arabica coffee products made in Indonesia is to export Arabica coffee as a producing nation (Ginting et al., 2023). People from all nations and eras have valued Arabica coffee for its unique flavour and aroma, as well as its invigorating and health-promoting properties (Hareessh, 2024).

Coffee is one of the most important commodities in the international market. Coffee is produced and exported by various countries and ranks at the top as a commercial crop in developing countries (Goshme, et al, 2023). Coffee is one of the most important tropical plantation crops traded in the international market (Rahmi et al., 2025). North Sumatra Arabica coffee has great potential for export to the international market, with its distinctive quality and unique taste being its main attractions. However, the export of North Sumatra Arabica coffee faces challenges in the form of fierce competition, high quality standards, and the need for efficient logistics. To increase exports, it is necessary to improve quality, branding and marketing, as well as expand access to international markets. Coffee is prioritized as a commodity because it is a source of foreign exchange and has high

economic value, coupled with the trend of coffee consumption among all age groups, which increases the demand for Arabica coffee beans. The government also plays an important role in supporting the export of North Sumatra Arabica coffee through incentives, capital assistance, market access facilitation, and other measures (Putra & Siahaan, 2022).

With an average yearly production of 69,001 thousand tonnes between 2019 and 2023—or 32.96% of the country's total production North Sumatra is one of Indonesia's primary Arabica coffee-producing regions (Ministry of Agriculture, 2023). The province has an advantage due to its location at an elevation of over 1000 meters above sea level and its tropical environment, which is ideal for growing premium Arabica coffee. Regencies such as Simalungun, Dairi, Karo, and North Tapanuli are known as production centers with agroclimatic characteristics that produce coffee with a distinctive flavor. North Sumatra's dominance in Arabica coffee production also influences the price structure, recording the highest producer prices in Indonesia in 2022, namely IDR 40,790/kg for coffee beans and IDR 31,810/kg for ground coffee, verifying the province's strategic contribution to enhancing Indonesian coffee's competitiveness on the global market (Central Statistics Agency, 2023).

The United States is the primary destination country for Arabica coffee exports from North Sumatra, with an average annual import of 31.99 thousand tonnes, followed by Japan with 4.53 thousand tonnes, Germany with 4.21 thousand tonnes, Belgium with 2.88 thousand tonnes, and Canada with 2.86

thousand tonnes, according to export data. The United States appears dominant with a wide gap in the graph, indicating the largest export contribution compared to other countries. However, there has been a downward trend in exports to all of these countries from 2015 to 2023, signaling a challenge that must be addressed immediately given the importance of Arabica coffee in the national trade balance.

The stability of North Sumatra's Arabica coffee exports is largely dependent on the United States, Japan, Germany, and Canada. Nonetheless, during the 2011–2023 timeframe, demand from each destination countries varies. A nation's high export volumes do not always translate into higher exports in the years that follow. Analysing the several elements that affect variations in the amount of Arabica coffee exported from North Sumatra to these four nations is therefore essential. It is anticipated that the government will use the study's strategic recommendations to boost North Sumatra's competitiveness in the world coffee market and increase export consistency.

Previous studies have identified factors that influence coffee exports, including domestic production volume, export prices, and the economic distance between exporting and importing countries. Other variables such as international coffee prices, exchange rates, and global economic conditions are also key determinants (Herdira & Hakim, 2021). According to research by Nasution and Lubis (2023), there is a positive and significant association between the volume of coffee exported from North Sumatra and the domestic price of Arabica coffee.

Studies examining the impact of global coffee prices on the number of Arabica coffee exports also produced inconsistent findings. Novariani, Muchtolifah, and Sishadiyati (2021) identified a negative and significant relationship between international coffee prices and arabica coffee export volume, while Maulani and Wahyuningsih (2021) showed a positive relationship between international coffee prices and arabica coffee export volume. Nasution and Lubis (2023) discovered a positive effect in the context of currency exchange rates, however Ginting and Kartiasih (2019) claimed a large negative effect. These conflicting results point to the necessity of more thorough and contextual empirical research.

The United States, Japan, Germany, and Canada are the four developed nations that are the special subject of this study. These four countries were selected based on their strategic position in the development and implementation of Industry 4.0 policies, as well as their significant contribution to the global economy. By limiting the scope of the study to these countries, a more in-depth and focused analysis can be conducted, particularly in evaluating the differences in approach, challenges, and impacts of industrial technology implementation on economic growth and industrial sector transformation in each country.

2 MATERIAL AND METHODS

2.1 Materials

This study uses panel data covering the four main export destinations for Arabica coffee from North Sumatra, namely Canada, Germany, Japan, and the United States, for the period 2011 to 2023, resulting in 52 observations. The dependent variable in this study is the volume of Arabica coffee exports from North Sumatra to these countries. Meanwhile, the independent variables include the international price of Arabica coffee, the gross domestic product of the importing countries, and the exchange rates of the importing countries.

The Central Statistics Agency, the Indonesian Coffee Exporters Association, the Ministry of Trade, the Ministry of Agriculture, and the World Bank are just a few of the official sources from which all of the secondary data used was gathered. The Indonesian Coffee Exporters Association provided data on export volumes, and the World Bank provided data on each nation's gross domestic product. The Ministry of Trade provided exchange rate data, the World Bank provided information on global coffee prices, and the North Sumatra Central Statistics Agency of Indonesia provided information on domestic coffee prices.

2.2 Panel Data Regression Methods

Panel data regression is regression with a panel data structure. Panel data is a combination of cross-sectional data and time series data. Data from one or more variables gathered for multiple people at one time is known as cross-sectional data. Time series data, on the other hand, are data gathered over time from one or more variables. Accordingly, the same cross-sectional units are gathered throughout time in panel data (Firdaus, 2019).

Since panel data is a combination of cross sectional and time-series data, the panel data regression model is as shown in Equation (1):

$$VECit = \beta_0 + \beta_1 PICit + \beta_2 ECRit + \beta_3 GDPit + \epsilon it \quad (1)$$

Explanation:

β_0 : Constant

$VECit$: Volume of North Sumatra Coffee Exports to the International Market

$PICit$: International arabica coffee price (US\$)

$ECRit$: USD exchange rate (US\$)

$GDPit$: The destination country's gross domestic GDP (US\$)

i : Shows how many countries there are

t : Indicates the time period

β : The coefficient of regression for every independent variable

ϵit : Error term in period t in country i

Three methods the Common Effect Model, Fixed Effect Model, and Random Effect Model can be applied to ascertain the outcomes of the panel data regression model estimate. Agus (2018).

2.2.1 Common Effect Model (CEM)

Without taking into account variations among time periods, people, or businesses, this model blends cross-sectional and time series data. This model makes the assumption that business practices are consistent across all time periods. The Ordinary Least Squares (OLS) approach is used in this model.

2.2.2 Fixed Effect Model (FEM)

The slope or regression coefficient between firms and time, as well as the intercept between times, are assumed to be fixed in this model. To find variations in intercepts or constants between businesses, this model employs dummy variables. The fixed effect model is also known as the Least Square Dummy Variable (LSDV) approach since it is estimated using OLS.

2.2.3 Random Effect Model (REM)

Businesses or persons with varying intercepts are assumed to be random variables in this model. The disturbance variables or error terms used in this approach to estimate panel data may exhibit time-varying correlations between individuals. This model employs the Generalised Least Squares (GLS) methodology.

2.3 Panel Data Regression Model Selection

The Chow, Hausman, and Lagrange multiplier tests are performed following the estimation of the three panel data regression models. In order to make conclusions regarding the model employed, this is to ascertain which model is most relevant and suited for this investigation (Mahyus, 2016).

2.3.1 The Chow Test

To ascertain which of the CEM and FEM models is superior, the Chow test is used. H_0 , which states that CEM is chosen, and H_1 , which states that FEM is chosen, are the hypotheses. Accept H_1 if the F-test value is greater than α (0.05) and the cross-section chi-square p-value is less than 0.05. On the other hand, accept H_0 if the F-test probability value is less than α (0.05) or the cross-section chi-square p-value is more than α (0.05). This decision will determine the next test. If FEM is selected, then the Hausman test is performed. Meanwhile, if CEM is selected, then the Lagrange Multiplier test is performed.

2.3.2 The Hausman Test

To determine which of the REM and FEM models is superior, the Hausman test is used. The FEM model is the null

hypothesis (H_1), and the REM model is the null hypothesis (H_0). H_1 is approved if the cross-section random p-value is less than α (0.05). On the other hand, H_0 is acceptable if the cross-section random test's p-value is $\geq \alpha$ (0.05). The process is finished if FEM is chosen, indicating that it is the most appropriate model for this investigation. The Lagrange Multiplier test is carried out next, though, if REM is chosen.

2.3.3 Test of Lagrange Multipliers

To determine whether of the CEM and REM models is superior, the Lagrange Multiplier Test, or LM, is used. The selection of CEM is the hypothesis (H_0), while the selection of REM is the hypothesis (H_1). H_1 is approved if both Breusch-Pagan values are less than α (0.05). In contrast, H_0 is allowed if both Breusch-Pagan values are greater than α (0.05).

2.3.4 Classical Assumption Test Test of Normalcy

Finding out if the variables in the panel data regression model are regularly distributed is the goal of the normality test. The Jarque-Bera approach can be used to formally detect the residuals' normalcy.

2.3.5 Multicollinearity Test

In a multiple linear regression model, the multicollinearity assumption denotes a strong linear relationship between a number of predictor variables. The tolerance and VIF values can be used to predict whether multicollinearity would exist or not.

2.3.6 Heteroscedasticity Test

When the variance of the observed model's error varies from observation to observation, this is known as heteroscedasticity. When a regression model exhibits homoscedasticity, or the variance of the error from one observation to another staying constant, it satisfies the conditions. The Glejser test and graphical techniques can be used to identify heteroscedasticity.

2.3.7 Test of Autocorrelation

The correlation that exists between two residual components is known as autocorrelation. The Durbin-Watson approach is one of the frequently utilised tests.

3 RESULTS

3.1 Estimated Results of a Panel Data Regression Model

The research data analyzed using the common-effects model can be seen in Table 1.

Table 1: Model for Estimating Common Effects.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	6826.570	2723.848	2.506223	0.0156
PIC	0.152678	0.087828	3.192211	0.0025
ECR	0.074604	0.116744	0.639037	0.5258
GDP	0.116971	0.007339	15.93852	0.0000

Source: Data Analysis Results.

The research data analyzed using the fixed-effects model can be seen in Table 2.

Table 2: Fixed Effect Estimation Model.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	13983.46	2215.228	6.312425	0.0000
PIC	0.055199	0.024469	2.255864	0.0290
ECR	0.418590	0.287256	1.457200	0.1520
GDP	-0.047451	0.016974	-2.795484	0.0076
Fixed Effects (Cross)				
CAN--C	-12695.37			
GER--C	-10987.28			
JPN--C	-3859.300			
USA--C	27541.95			

Source: Data Analysis Results.

The research data analyzed using a random-effects model are presented in Table 3.

Table 3: Random Effect Estimation Model.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	10064.56	1656.409	6.076134	0.0000
PIC	0.125548	0.023358	5.375055	0.0000
ECR	-0.086744	0.113626	-0.763421	0.4489
GDP	0.085744	0.007048	12.16628	0.0000
Effects Specification				
		S.D.	Rho	
Cross-section random		1322.932	0.2316	
Idiosyncratic random		2409.358	0.7684	

Source: Data Analysis Results.

3.2 Chow Test Results (Common vs Fixed Effect)

$H_0: \mu_1 = \mu_2 = \dots = \mu_3 = 0$ (Common Effect model is better than Fixed Effect model)

H_1 : at least one $\mu_i \neq 0$ for $i=1,2,\dots,4$ (Fixed Effect model is better than Common Effect model) Critical region: (Equation 2):

$$F_{(\alpha; n-1, nT-n-K)} = F_{(0.05; 3, 45)} = 2,811 \quad (2)$$

Coffee Science, 21:e212460, 2026

The research data analyzed using the Chow test can be seen in Table 4.

Table 4: Chow Test Results (Common vs Fixed Effect).

Redundant Fixed Effects Tests			
Equation: Untitled			
Test cross-section fixed effects			
Effects Test	Statistic	d.f.	Prob.
Cross-section F	54.706569	(3,45)	0.0000
Cross-section Chi-square	79.884706	3	0.0000

Source: Data Analysis Results.

Decision: Reject H_0

At a 95 percent confidence level or 5 percent error rate, the intercepts for each export destination country are not the same or there are differences in individual effects, meaning that the fixed effect model is better than the common effect model.

3.3 Hausman Test Results (Random vs Fixed Effect)

$H_0: \text{cov}(\varepsilon_{it}, X_{it}) = 0$ (Random Effect model is better than Fixed Effect model)

$H_1: \text{cov}(\varepsilon_{it}, X_{it}) \neq 0$ (Fixed Effect model is better than Random Effect model)

Critical region: (Equation 3):

$$X^2_{\alpha; k} = X^2_{0.05; 3} = 7,81 \quad (3)$$

The research data analyzed using the Hausman test can be seen in Table 5.

Table 5: Hausman Test Results (Random vs Fixed Effect).

Test Summary	Chi-Sq. Statistic	Chi-Sq. d.f.	Prob.
Cross-section random	120.239068	3	0.0000

Source: Data Analysis Results.

Decision: Reject H_0 .

At a 95 percent confidence level or a 5 percent error rate, it can be concluded that the fixed effect model is better than the random effect model.

3.4 Results of Heteroscedasticity Detection of Variance Covariance Structure

$H_0: \sigma^2_i = \sigma^2 = 0$ for $i=1,2,\dots,4$ (covariance structure of residuals is homoscedastic)

H_1 : at least one $\sigma^2_i \neq \sigma^2$ covariance structure of residuals is heteroscedastic)

 $\alpha = 0.05$

Critical region: (Equation 4 and 5):

$$\chi^2_{\alpha; n-1} = \chi^2_{0,05;4} = 9,4877 \quad (4)$$

Test Statistics:

$$\lambda_{LM} = \frac{T}{2} \sum_{i=1}^n \left[\frac{\hat{\sigma}_i^2}{\hat{\sigma}^2} - 1 \right]^2 = \frac{13}{2} \sum_{i=1}^n \left[\frac{\hat{\sigma}_i^2}{\hat{\sigma}^2} - 1 \right]^2 = 49,13004 \quad (5)$$

$\hat{\sigma}_i^2$ = Residual variance of the fixed effects model's i-th equation

$\hat{\sigma}^2$ = The residual variance of the model with fixed effects

The research data for detecting heteroscedasticity in the variance-covariance structure can be found in Table 6.

Table 6: Results of Heteroscedasticity Detection of Variance Covariance Structure.

Panel Cross-section - Heteroskedasticity LM Test			
Equation: EQ01			
Specification: VEC C PIC ECR GDP			
Null hypothesis: Residuals are homoskedastic			
	Value	d.f.	Prob.
LM Test	49.13004	3	0.0000

Source: Data Analysis Results.

Decision: Reject H_0 , because the test statistic > critical region (49.13004 > 9.4877).

At a 95 per cent confidence level or 5 per cent error rate, it can be concluded that the residual variance-covariance structure is heteroscedastic.

3.5 Results of Cross Sectional Correlation Test on Heteroskedastic Estimator Structure

$H_0: \rho(\varepsilon_{it}, \varepsilon_{jt}) = 0$ (No relationship exists between cross section defects).

$H_1: \rho(\varepsilon_{it}, \varepsilon_{jt}) \neq 0$ (Cross section errors are correlated with one another).

$\alpha = 0,05$.

The results of the cross-sectional correlation test on the structure of the heteroscedastic estimator can be seen in Equations 6 and 7.

Critical region:

$$\chi^2_{\alpha; N(N-1)/2} = \chi^2_{0,05;6} = 12,59 \quad (6)$$

Test Statistics:

$$\lambda_{LM} = T \sum_{i=2}^N \sum_{j=2}^{i-1} r_{ij}^2 = 13 \sum_{i=2}^N \sum_{j=2}^{i-1} r_{ij}^2 = 11,45 \quad (7)$$

The research data for the residual cross-sectional dependence test can be found in Table 7.

Table 7: Results of Cross Sectional Correlation Test on Heteroskedastic Estimator Structure.

Test	Statistic	d.f.	Prob.
Breusch-Pagan LM	11.45287	6	0.0753
Pesaran scaled LM	1.574109		0.1155
Bias-corrected scaled LM	1.407442		0.1593
Pesaran CD	2.090575		0.0366

Source: Data Analysis Results.

r_{ij}^2 = coefficient of residual correlation between equations i and j.

Decision: Fail to reject H_0 , because the test statistic < critical region (11.45 < 12.59) or p-value > 0.05.

At a 95 per cent confidence level or 5 per cent error rate, it can be concluded that the residual covariance variance structure is heteroscedastic and there is no correlation between cross-section residuals. To overcome this heteroscedasticity problem, an FEM model was formed using the GLS estimation method with cross-section weight correction.

3.6 Output Model Fixed Effect Cross Section Weights

The results of the fixed-effects cross-sectional model with weights are presented in Table 8.

Table 8: Output Model Fixed Effect Cross Section Weights.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	16227.36	1453.674	11.16300	0.0000
PIC	0.047057	0.080445	4.505380	0.0000
ECR	0.307536	0.099338	3.095849	0.0034
GDP	-0.063424	0.019151	-3.311852	0.0018
Fixed Effects (Cross)				
CAN--C	-13573.17			
GER--C	-11264.31			
JPN--C	-5565.286			
USA--C	30402.77			

Source: Data Analysis Results.

The R^2 value, as determined by the regression equation calculation, is 0.934740. This indicates that the dependent variable (volume of Arabica coffee exported) can be explained by 93.47% of the variation in the independent variables (international Arabica coffee prices, destination country exchange rates, and destination country gross domestic product), with the remaining 6.53% coming from variables not included in the regression model.

All of the independent variables in the model have a considerable impact on the volume of Arabica coffee

exports, according to the estimation results obtained using the GLS approach. An increase in the price of Arabica coffee on the international market stimulates an increase in Arabica coffee exports from North Sumatra, according to the international Arabica coffee price variable, which has a positive coefficient of 0.047 and is significant at the 1% error level. With a coefficient of 0.307, the destination country's currency exchange rate versus the rupiah likewise has a favourable and noteworthy impact. This implies that the purchase power of Indonesian export goods, such as Arabica coffee, will rise if the importing nation's currency appreciates vs the rupiah. On the other hand, there is a negative correlation between the volume of Arabica coffee exports and the destination country's GDP, with a coefficient of -0.063 that is significant at the 5% level. The Arabica coffee export volume panel data regression equation looks like this: (Equation 8, 9, 10 and 11):

$$VEC_{CAN} = 2654,19 + 0.047 PIC + 0.308 ECR - 0,063 GDP \quad (8)$$

$$VEC_{GER} = 4963,05 + 0.047 PIC + 0.308 ECR - 0,063 GDP \quad (9)$$

$$VEC_{JPN} = 10662,07 + 0.047 PIC + 0.308 ECR - 0,063 GDP \quad (10)$$

$$VEC_{USA} = 46630,13 + 0.047 PIC + 0.308 ECR - 0,063 GDP \quad (11)$$

3.7 Classical Assumption Test Results

a. Multicollinearity Test Results

The research data for the multicollinearity test can be found in Table 9.

Table 9: Results of the Classical Assumption Test.

	Coefficient	Uncentered	Centered
Variable	Variance	VIF	VIF
C	2113167.	106.9260	NA
PIC	0.000109	15.83325	1.191837
ECR	0.009868	54.02150	1.604930
GDP	0.000367	170.8381	1.601217

Source: Data Analysis Results.

Decision: Reject H_0 .

Since all VIF (Centred VIF) values are less than 10, it can be concluded that there is no multicollinearity.

b. Normality results

$H_0 : \varepsilon_{it} \sim N(0, \sigma^2)$ (Error is normally distributed)

$H_1 : \varepsilon_{it} \sim N(0, \sigma^2)$ (Error is not normally distributed)

$\alpha = 0.05$

$N = 4$ (number of export destination countries)

$S = 0.609770$

$K = 3.513770$

Critical Region: (Equation 12 and 13):

$$\chi^2_{\alpha;2} = \chi^2_{0,05;2} = 5,9914 \quad (12)$$

Test Statistics:

$$JB = n \left[\frac{S^2}{6} + \frac{(k-3)^2}{24} \right] = 1,712 \quad (13)$$

JB = Jarque-Bera statistic value

S = skewness value of OLS residuals

κ = kurtosis value of OLS residuals

The results of the normality test are shown in Figure 1.

At a confidence level of 95 per cent or a margin of error of 5 per cent, it can be concluded that the residuals of the fixed effect model are normally distributed.

c. Results of the Autocorrelation Test

The research data for the autocorrelation test can be found in Table 10.

At a 95 per cent confidence level or 5 per cent error rate, it can be concluded that the fixed effect model residuals do not exhibit autocorrelation.

d. Homoscedasticity Test Results (Glejser Test)

The research data for the Glejser test can be found in Table 11.

At a 95 per cent confidence level or 5 per cent error rate, it can be concluded that the fixed effect model residuals do not exhibit heteroscedasticity.

3.8 Simultaneous Regression Coefficient Test Results (F-test)

$H_0 : \beta_1 = \beta_2 = \beta_3 = \beta_4 = 0$

H_1 : at least one $\beta_i \neq 0$, for $i = 1, 2, 3, 4$

$\alpha = 0.05$

Critical Region: (Equation 14):

$$F_{(\alpha; K-I; NT-N-K)} = F_{(0,005;2;45)} = 3,204 \quad (14)$$

The data from the simultaneous regression coefficient test (F-test) can be found in Table 12.

Simultaneously, or the F test, shows that all independent variables collectively have a significant effect on the dependent variable (coffee export volume), with an F value of 107.42 and a p-value of $0.0000 < 0.05$, or with a 5 per cent error rate.

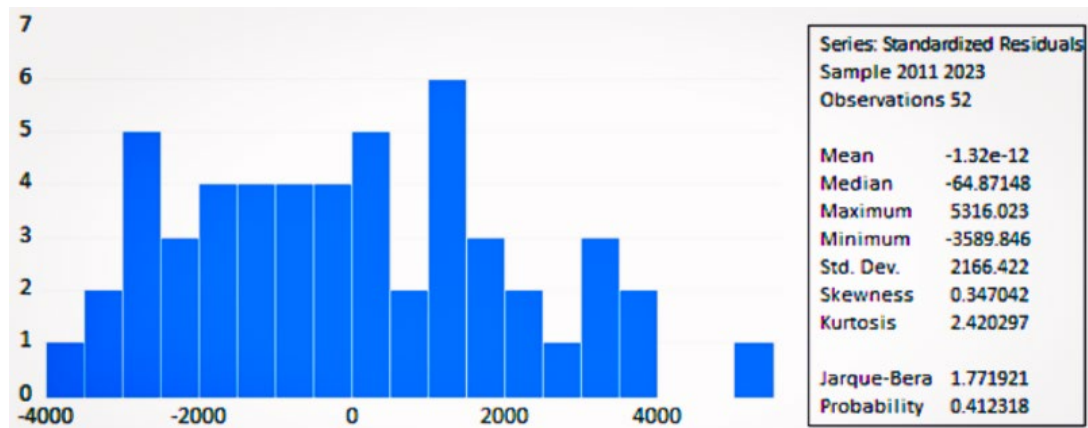


Figure 1: Normality test results.

Decision: Reject H_0 .

Table 10: Results of the Autocorrelation Test.

Weighted Statistics						
Root MSE	2145.490	R-squared	0.934740			
Mean dependent var	11251.15	Adjusted R-squared	0.926038			
S.D. dependent var	4798.151	S.E. of regression	2306.332			
Sum squared resid	2.39E+08	F-statistic	107.4241			
Durbin-Watson stat	1.453533	Prob(F-statistic)	0.000000			
<i>n</i>	<i>k</i>	<i>d_L</i>	<i>d_U</i>	<i>4 - d_L</i>	<i>4 - d_U</i>	<i>DW</i>
52	3	1,4339	1,6769	2,5661	2,3231	1,4535

Decision: Reject H_0 .

Table 11: Homoscedasticity Test Results (Glejser Test).

Dependent Variable: ABS(RESID02)				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	2727.095	713.7793	3.820641	0.0004
PIC	0.000895	0.006162	0.145252	0.8852
ECR	0.100090	0.061733	1.621328	0.1119
GDP	-0.024260	0.009031	-2.686199	0.0501

Source: Data Analysis Results.

Decision: Reject H_0 .

Table 12: Simultaneous Regression Coefficient Test Results (F-test).

Weighted Statistics			
Sum squared resid	2.39E+08	F-statistic	107.4241
Durbin-Watson stat	1.453533	Prob(F-statistic)	0.000000

Source: Data Analysis Results.

Decision: Reject H_0 .

3.9 Partial Regression Coefficient Test Results (t-test)

$$H_0: \beta_i = 0, \text{ for } i = 1, 2, 3, 4$$

$$H_1: \beta_i \neq 0, \text{ for } i = 1, 2, 3, 4$$

$$\alpha = 0.05$$

N = 4 (number of export destination countries)

T = 13 (number of research periods)

K = 3 (number of independent variables)

Critical Region: (Equation 15 and 16):

$$t_{(\alpha; NT - N - K)} = t_{(0.05; 56)} = 2,003 \quad (15)$$

Test Statistics:

$$t_{hitung} = \frac{\hat{\beta}_i - \beta_i}{se(\hat{\beta}_i)} \quad (16)$$

The research data for the partial regression coefficient test (t-test) can be found in Table 13.

Table 13: Results of the Partial Regression Coefficient Test (t-test).

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	16227.36	1453.674	11.16300	0.0000
PIC	0.047057	0.010445	4.505380	0.0000
ECR	0.307536	0.099338	3.095849	0.0034
GDP	-0.063424	0.019151	-3.311852	0.0018

Source: Data Analysis Results.

Decision: Reject H_0 ($|t_{hitung}|$) for all research variables.

Partially, or t-test, reinforces the finding that international Arabica coffee prices and the exchange rate of the destination country have a positive and significant effect on the volume of Arabica coffee exports. On the other hand, the gross domestic product of the destination country has a negative and significant effect on the volume of Arabica coffee exports from North Sumatra with a 5 per cent error rate.

The results of the analysis of the fixed-effect model coefficients for export destination countries are presented in Table 14.

Tabel 14: Interpretasi Koefisien Fixed Effect Model Negara Tujuan Ekspor.

Country	a (Main Constant)	Random Constant Coefficient μ	Intercept Coefficient (Total Constant)
Canada		-13573.17	2654.19
Germany	16227.36	-11264.31	4963.05
Japan		-5565.286	10662.07
United States		30402.77	46630.13

Source: Data Analysis Results.

The demand for North Sumatra Arabica coffee exports from each destination country will be impacted separately if the global price of Arabica coffee, the rupiah exchange rate, and the gross domestic product of the destination country fluctuate over time and between regions. The United States shows the highest individual effect of 46630.13, indicating the largest contribution and sensitivity of the market to Arabica coffee exports from North Sumatra. Japan follows with an individual effect of 10662.07, followed by Germany with 4963.05, and Canada with 2654.19. These differences in individual effect values reflect that each country has its own level of influence on the demand for Arabica coffee exports. These differences in individual effect values reflect that each country has its own level of influence on the demand for North Sumatra Arabica coffee.

4 DISCUSSION

4.1 The Impact of Global Arabica Coffee Prices on North Sumatra's Arabica Coffee Export Volume

The study's findings demonstrate that the amount of Arabica coffee exported from North Sumatra to important destination nations is positively and significantly impacted by global Arabica coffee prices. This suggests that the performance of Arabica coffee exports from North Sumatra is significantly influenced by changes in the price of Arabica coffee globally. High international Arabica coffee prices provide incentives for farmers and producers to increase Arabica coffee production and sell their Arabica coffee to the international market. Increased Arabica coffee production then translates into increased Arabica coffee export volume from North Sumatra. The country's economy also benefits from favourable worldwide Arabica coffee prices, which raise foreign exchange earnings and Arabica coffee producers' incomes.

The study's findings are consistent with those of Suherman et al. (2023) investigation, which discovered that the value of Indonesian coffee exports is significantly and favourably impacted by global coffee prices. Pratiwi et al. (2023) have revealed similar results, demonstrating that the value of Indonesian coffee exports is positively and

significantly impacted by any increase in global coffee prices. Economically speaking, producers may offer larger amounts to the global market as a result of rising commodity prices.

Since exporters make more money when prices rise on the international market, export volume rises as well. These results are consistent with studies by Lubis et al. (2022), which discovered that the value of Indonesian coffee exports is greatly impacted by global coffee prices. This indicates that global price fluctuations are an important factor in determining the export performance of North Sumatra, Indonesia. This condition encourages farmers and coffee industry players to improve product quality, accelerate crop distribution, and expand marketing networks to meet the increasingly competitive standards for Arabica coffee exports.

Exporters play an important role in pricing in two main ways: controlling prices by channeling excess production to foreign markets to prevent domestic prices from falling, and setting international prices by negotiating the sale of local products in global markets. In addition, exporters also help raise average selling prices due to higher productivity or better coffee product quality that competing countries do not have (Fikri & Puspita, 2024).

4.2 The Impact of the Importing Country's Currency Exchange Rate on the Volume of North Sumatra's Arabica Coffee Exports

The amount of Arabica coffee exported from North Sumatra is positively and significantly impacted by the currency exchange rate of the importing nation. Arabica coffee from North Sumatra will be more affordable in the view of the importing nation if its exchange rate declines relative to its own currency. This will increase competitiveness and increase the volume of Arabica coffee exported. On the other hand, if the importing nation's currency appreciates, the cost of Arabica coffee will rise, thereby decreasing North Sumatra's competitiveness and export volume.

The results of the study show that the rupiah exchange rate has a positive and significant effect on North Sumatra's Arabica coffee exports in the short term. This means that fluctuations in the rupiah exchange rate in the near future have a direct and tangible impact on the volume of Arabica coffee exports. If the rupiah exchange rate weakens against foreign currencies, the price of North Sumatra Arabica coffee will become more competitive in the international market in a short period of time. This instantly increases its appeal to importers, who respond by increasing orders due to the more favorable prices. Therefore, exchange rate stability in export destination countries is a strategic component in maintaining the sustainability of Arabica coffee exports. These findings emphasize the need for an exchange rate risk management approach, either through hedging mechanisms or export

market diversification, so that Arabica coffee businesses can increase their resilience to external shocks originating from global macroeconomic dynamics.

The findings of this study are consistent with those of a study conducted in 2022 by Savira, Anindita, and Nugroho (2022), which found that Indonesian coffee exports are positively and significantly impacted by the actual exchange rate. According to their research, a drop in the real exchange rate (in USD) is closely correlated with an increase in Arabica coffee exports' competitiveness, which in turn raises their volume. In this case, one important element that makes price comparisons easier and makes Arabica coffee goods more appealing on the international market is the use of direct terms (exchange rate per USD).

The amount of coffee exported from Indonesia is positively and significantly correlated with foreign exchange rates relative to the rupiah, according to research by Pratama and Budhi (2023). International commerce theory states that when the value of the home currency declines, export goods in foreign currencies become more affordable, drawing in foreign customers. As a result, an increase in export volume is indirectly encouraged by the export destination country's currency appreciation, which is inversely proportionate to the rupiah exchange rate.

Research by Agustina et al. (2024) shows that the rupiah exchange rate has a positive and significant effect on Indonesian coffee bean exports in the short term. The rupiah exchange rate has a negative and insignificant effect on Indonesian coffee bean exports in the long term.

The exchange rate has a coefficient value of 0.6902. This figure increased by 1%, contributing to a 69.02% increase in the volume of North Sumatra coffee exports to the United States, Malaysia, and Japan. This was determined by the growth of the exchange rate to the United States, Malaysia, and Japan of 8.65%, 7.04%, and 13.09%, respectively. The partial effect of the exchange rate is significant in increasing the volume of Arabica coffee exports from North Sumatra to the United States, Malaysia, and Japan, which is caused by the existence of Arabica coffee export substitute countries and the highest per capita income, thereby influencing the habit of people to always consume Arabica coffee in the United States, Malaysia, and Japan (Sihombing et al., 2021).

4.3 The Impact of Importing Countries' Gross Domestic Product on the Volume of Arabica Coffee Exports from North Sumatra

The increase gross domestic product of Arabica coffee export destination countries, while domestic Arabica coffee exports decline, can be attributed to several factors. An increase in gross domestic product may indicate an increase in income and purchasing power in that country, which should drive

demand for Arabica coffee. However, the decline in exports may be due to internal factors such as uncompetitive quality or changes in consumer preferences. The decline in the quality of Arabica coffee may reduce exports of Arabica coffee from North Sumatra. Another factor is that Arabica coffee from North Sumatra may be less competitive than coffee from other countries that is of better quality or more competitively priced. Global supply chain dynamics and consumer preference structures also have an impact on how sensitive Arabica coffee exports are to the GDP of the destination nation. In markets with high Gross Domestic Product, consumers tend to be more aware of the quality and sustainability of a product, so Arabica coffee that is certified organic, fair trade, and has a geographical indication is more likely to penetrate international markets and obtain premium prices. This creates both opportunities and challenges for North Sumatra Arabica coffee farmers and exporters to continue adjusting production standards to global market expectations in order to increase Arabica coffee exports. Consumers in destination countries may switch to other types of coffee, or to value-added coffee products such as packaged coffee or instant coffee.

The findings of this study are consistent with those of Sihombing et al. (2021) investigation, which demonstrates a negative and noteworthy correlation between GDP per capita and the volume of coffee exported. In markets with high GDP, consumers tend to be more aware of quality and sustainability, so coffee with organic, fair trade, and geographical indication certifications is easier to penetrate the market and obtain premium prices. This creates opportunities and challenges for farmers and exporters in North Sumatra to continue adjusting production standards to global market expectations.

The results of research conducted by Asmara et al. (2024) show a negative influence between the GDP of the United States and the volume of Indonesian coffee exports due to the diversification of coffee import sources by the United States. As a country with a large market, the United States does not only depend on coffee from Indonesia but also imports from other countries such as Brazil, Vietnam, and Colombia.

Policymakers and anyone involved in the coffee sector should take note of these findings and concentrate more on external issues that may be controlled, such stable exchange rates and more competitive products. Adaptive marketing tactics and enhancements to product quality are essential for managing the fluctuations of global markets. Therefore, to increase North Sumatra coffee's export performance, industry participants and the government must work together.

5 CONCLUSIONS

International Arabica coffee prices and exchange rates have a positive and significant effect on Arabica

coffee export volumes, while the gross domestic product of importing countries has a negative and significant effect on Arabica coffee export volumes. Rising global prices and the appreciation of the destination country's currency drive Arabica coffee exports. The implication is that stakeholders need to strategically anticipate responses to the global market. Recommendations include assessing the quality of Arabica coffee beans to boost exports.

6 AUTHORS' CONTRIBUTION

Conceptual Idea: Rahmanta; Tavi, S.; Lindawati; Nasution, S.K.H.; Methodology design: Rahmanta; Tavi, S.; Lindawati; Data collection: Rahmanta; Tavi, S.; Nasution, S.K.H.; Data analysis and interpretation: Rahmanta; Tavi, S.; Lindawati; Nasution, S.K.H.; and writing and editing: Rahmanta; Tavi, S.; Lindawati; Nasution, S.K.H.

7 DATA AVAILABILITY STATEMENT

Data available upon request to authors

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